VERSION WITH MARKINGS TO SHOW CHANGES

IN THE SPECIFICATION:

Page 11, line 6, change "12" to --14--.

IN THE CLAIMS:

9. (amended) An apparatus for controlling the power at the output of an internal combustion engine coupled to a transmission wherein the rate of change of ratio of said transmission is controllable, comprising:

(a) an electric motor positioned between said engine and said transmission; and

(b) a controller which varies torque output of said electric motor and the rate of change of the ratio of said transmission;

(c) wherein, for any given speed, the controller sets engine power output in accordance with predetermined operating characteristics[.]; and

(d) wherein said electric motor varies engine power output.

19. (amended) A control apparatus for an internal combustion engine driving a continuously variable transmission and a driveshaft coupled to said continuously variable transmission wherein the rate of change of ratio of said continuously variable transmission is controllable, comprising:

(a) a generator/motor mechanically coupled to and driven by said engine;

(b) a generator/motor controller electrically connected to said generator;

(c) a motor/generator mechanically coupled to said drive shaft;

(d) a battery electrically connected to said generator/motor controller and said motor/generator controller;

(e) said generator/motor, said generator/motor controller, said motor/generator, said motor/generator controller, and said battery comprising said continuously variable transmission; and

(f) a controller which varies torque output of said generator/motor and the rate of change of the ratio of said continuously variable transmission;

(g) wherein, for any given speed, said controller sets engine power output in accordance with predetermined operating characteristics; and

(h) wherein said generator/motor varies engine power output.

20. (amended) A control apparatus for a vehicle having an internal combustion engine driving a transmission, wherein said transmission has an output driving a first wheel at a first end of said vehicle wheel, and wherein the rate of change of ratio of said transmission is controllable, comprising:

(a) an electric motor driving a second wheel at a second end of said vehicle;

(b) a motor controller electrically connected to said motor;

(c) said motor coupled to said transmission through a road surface; and

(d) control means for varying torque output of said motor and for varying the rate of change of the ratio of said continuously variable transmission;

(e) wherein, for any given speed, said control means sets engine power output in accordance with predetermined operating characteristics; and

(f) wherein said electric motor varies engine power output.

21. (amended) A control apparatus for a vehicle having an internal combustion engine, an electric motor coupled to said engine and driving a transmission, and a battery system powering the electric motor, comprising:

a motor controller electrically connected to said electric motor;

wherein said motor controller varies torque output of said motor to be on an ideal operating line as determined by empirical testing of the electric motor and battery system; and

wherein said electric motor varies engine power output.

22. (amended) A control apparatus for a vehicle having an internal combustion engine and an electric motor, wherein said internal combustion engine and said electric motor are coupled to a continuously variable transmission, and wherein the rate of change of ratio of said continuously variable transmission is controllable, comprising:

(a) an engine controller mechanically connected to said internal combustion engine;

(b) a motor controller electrically connected to said electric motor; and

(c) control means associated with said engine controller and said motor controller for varying torque output of said motor and for varying rate of change of the ratio of said transmission;

(d) wherein, for any given speed, said control means sets engine power output in accordance with predetermined operating characteristics; [and]

(e) wherein said control programming includes hybrid, electric, and braking modes; and

(f) wherein said electric motor varies engine power output.

REMARKS

Reconsideration of this application is respectfully requested in view of the foregoing amendments and discussion presented herein.

1. Objection to Specification.

The Examiner objected to the specification and requested correction thereof for the stated reason that "in page 11, lines 9-13, applicant refers to figure 7 which indicates that the electric motor is at the rear and the CVT at the front, but figure 7 shows the electric motor at the front and the CVT at the rear according to rear wheel 62 and front wheel 58."

In response, the Applicant respectfully suggests that the Examiner has misread that portion of the specification. FIG. 7 shows the electric motor at the front of the vehicle and the CVT at the rear of the vehicle, and that configuration is described at page 11, lines 3-9.

At page 11, lines 9-13 referenced by the Examiner, the Applicant has described an alternative configuration; namely, one in which the positions of the electric motor and the CVT are reversed. In particular, the Applicant states that "it will be appreciated that the drive wheels may also be reversed, with the electric motor at the rear and the engine and CVT at the front of the vehicle. In this case, the electric motor controls the engine through the CVT, the output of which is controlled through the road." This is an alternative embodiment that is not shown in FIG. 7.

Therefore, the Applicant respectfully submits that there is no error in the specification and that correction is not required.

2. Objection to the Drawings.

(a) The Examiner objected to the drawings and requested correction for the stated reason that "reference numbers "12" and "14" have both been used to designate the clutch." The Examiner did not indicate where this error occurred.

In response, the Applicant was able to find one instance where element 12 was erroneously used to indicate a clutch; namely, at page 11, line 6. Element 12 is a shaft and element 14 is a clutch. The specification has been corrected accordingly, and the Applicant apologizes for the typographical error.

(b) The Examiner also objected to the drawings and requested correction for the stated reason that reference number "34" which appears on the drawings is not mentioned in the description.

In response, the Applicant respectfully calls to the Examiner's attention that reference number "34" appears at page 18, line 15 and at page 24, line 2.

Therefore, the Applicant respectfully submits that there is no error and that correction is not required.

3. Rejection of Claim 21 under 35 U.S.C. §112, first paragraph.

The Examiner rejected Claim 21 as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, with which it is most nearly connected, to make and/or use the invention. The reason stated by the Examiner was that Claim 21 discloses the "motor to be on an ideal operating line." The Examiner questioned whether the Applicant is "stating that the invention is perfect by stating that the motor can operate ideally and that it can output an ideal (perfect) torque."

In response, the Applicant notes that the phrase "ideal operating line" is defined in the specification and, therefore, Claim 21 meets the requirements of 35 U.S.C. §112, first paragraph. More particularly, the Applicant refers the Examiner to the discussion of the background art at page 2, line 20 through page 3, line2 where IOL is described as the ideal torque/speed operating line and denotes where the best efficiency and/or least emissions (minimum brake specific fuel consumption or BSFC) occurs. The Applicant also refers the Examiner to page 5, lines 19-21 where "ideal operating line (IOL)" is described as the operating line where the engine produces the best efficiency and minimum emissions for a given power of the engine, as well as to the language of Claim 21 itself where the term is defined as being determined by empirical testing.

Note also that the terms "ideal operating line" and "ideal torque/speed operating line" are used interchangeable in the art, and one of ordinary skill in the art would clearly understand from the specification and further description in Claim 21 that the IOL is determined empirically, how to practice the invention recited in Claim 21.

Furthermore, a brief search on the term "ideal operating line" on the Internet by the Applicant's attorney on August 9, 2001 yielded two publications being submitted herewith that discuss the term "ideal operating line" and its characteristics. Those publications are Brace et al., "Operating Point Optimiser for Integrated Diesel/CVT Powertrain", Ford Motor Company, Application of Powertrain and Fuel Technologies to Meet Emissions Standards for the 21st Century, Seminar Code C517, June 24-26, 1996, pp. 1-8; and Brace et al., "Integrated Passenger Car Diesel CVT Powertrain Control for Economy and Low Emissions", Ford Motor Company, EmechE International Seminar S540, Advanced Vehicle Transmissions and Powertrain Management,

September 25-26, 1997, pp. 1-8.

Therefore, the Applicant respectfully submits that the Claim 21 meets the requirements of 35 U.S.C. §112, first paragraph.

4. Rejection of Claims 4-11, 15-20 and 22 under 35 U.S.C. §112, second paragraph.

(a) Claims 4, 9, 15, 20 and 22. The Examiner rejected these claims for the stated reason that it was not clear from the phrase "sets engine power output in accordance with predetermined operating characteristics" what characteristics can set a power output.

In response, the Applicant respectfully notes that it is not the operating characteristics that set the engine power output, but the controller that sets the engine power output according to predetermine operating characteristics as recited in the subject claims. If these claims are read in combination with their base claims, this should be very clear. The controller, operating in response to sensed conditions and predetermined operation guideline (e.g., software), varies engine power output using the electric motor (or generator) as a regulating device. The specific operating characteristics are determined in advance and set into the controller by the operating software or the like. Hence, the terminology "predetermined operating characteristics". These can include torque vs. speed, emissions levels, etc. as described in the specification.

Therefore, the Applicant respectfully submits that Claims 4, 9, 15, 20 and 22, as well as the claims that depend therefrom, meet the requirements of 35 U.S.C. §112, second paragraph.

(b) Claims 6 and 18. The Examiner rejected these claims for the stated reason that the Examiner could not determine if the Applicant was disclosing two changes of ratio for the transmission, or a change of ratio within a change of ratio which both changes of ratio seem to be independent of each other.

In response, the Applicant respectfully expresses confusion over the Examiner's questions and apparent interpretation of these claims. Looking at the language of Claim 6, for example, the first part of the claim recites that the "rate of change of ratio of said transmission is controllable". This establishes antecedent basis for referring to a transmission having a controllable rate of change of ratio. The second part of the claim recites that the apparatus includes "means for controlling the rate of change of ratio" which can only refer to controlling the rate of change of ratio in the transmission as recited the first part of the claim. Therefore, the Applicant does not understand the basis for the Examiner's rejection.

In view of the above, the Applicant respectfully submits that the claim language is clear and meets the requirements of 35 U.S.C. §112, second paragraph. The Applicant respectfully questions whether the Examiner's difficulty with the language is the Applicant's use of "the" instead of "said"; if so, this is a problem that is easily remedied. However, "the" is commonly used as an alternative to "said" and the language is clear as written.

(c) Claims 7, 10 and 19. These claims were rejected for the stated reason that the claims recite a "continuously variable transmission" and the Examiner questioned whether that meant that the transmission will be working at all times when the vehicle is running in combustion mode or hybrid/electric mode.

In response, the Applicant respectfully notes that a "continuously variable transmission" or CVT is a device which is well known in the art and which one of ordinary skill would readily understand to comprise such a device from this terminology. A brief review of the references of record and/or literature pertaining to electric vehicle technology will verify that such a device is well known in the art.

Therefore, the Applicant does not understand that basis for the Examiner's rejection. The applicant uses the term "continuously variable transmission" with the same meaning as normally used in the field of electric vehicles and has not redefined that term in the instant application. Accordingly, the Applicant respectfully submits that Claims 7, 10 and 19 meet the requirements of 35 U.S.C. §112, second paragraph.

(d) Claim 5. This claim was listed in the group of claims rejected by the Examiner but no reason for the rejection was given. After reviewing Claim 5, the Applicant cannot find any language therein that corresponds to the language objected to by the Examiner in connection with the other listed claims.

5. Rejection of Claims 1-22 for Double Patenting.

The Examiner rejected Claims 1-22 under the judicially created doctrine of obviousness-type double patenting over Claims 1-21 of U.S. Patent No. 6,054,844 which is the parent of this application.

In response, the Applicant is submitting herewith a Terminal Disclaimer. Accordingly, the Applicant respectfully requests that the grounds for rejection be withdrawn.

6. Rejection of Claims 1-11, 21 and 22 under 35 U.S.C. §102(e).

Claims 1-11, 21 and 22 were rejected under 35 U.S.C. §102(e) as being

anticipated by Ibaraki et al. In support of the rejection, the Examiner described several elements of the Ibaraki et al. apparatus which essentially form a conventional hybrid vehicle configuration. In particular, the Examiner states that "Ibaraki et al discloses an apparatus for controlling the power at the output of an internal combustion engine, comprising an electric motor 14 coupled to the engine and a motor controller 28."

(a) Claims 1-8. In response to the rejection of Claims 1-8, the Applicant respectfully traverses the rejection for the reason that the Examiner has misread both Ibaraki et al. and the Applicant's claims. Ibaraki et al. shows an electric motor 14 which is coupled to transmission 16. Engine 12 is also coupled to transmission 16 through clutch 30 that is positioned between engine 12 and motor 14. Clutch 30 functions to connect engine 12 to transmission 16 to power the vehicle as described, for example, at col. 11, lines 32-35. At other times, the electric motor is used to power the vehicle. The Ibaraki et al. apparatus is configured to operate in a low-load drive mode where the vehicle is powered by the electric motor, a high-load drive mode where the vehicle is powered by the engine, and an emergency mode where either power source can be selectively operated as the normal drive power source.

However, there is nothing in Ibaraki et al. that discloses the use of motor 14 to vary the power output of the engine. As with any hybrid vehicle, Ibaraki et al. uses the motor to power the vehicle via controller 28 according to predetermined operating criteria. In contrast, the Applicant's motor and motor controller are configured to vary engine power output. This is a radical departure from other hybrid vehicle control schemes such as in Ibaraki et al. Conventional hybrid vehicles use the engine and motor, either separately or in combination, to power the vehicle and employ various

control methods to determine when each should operate. However, neither Ibaraki et al. nor any of the other cited references teach, suggest or provide motivation or incentive for connecting the electric motor to the output of the engine and then using the motor to vary (e.g., control) the output of the engine.

As explained in the Applicant's specification, a motor or generator is controlled to counteract the negative effect of the $-\dot{R} I_E S_E$ in the dynamic equation

$$\alpha_{DS} = \frac{-\dot{R} I_E S_E + T_E R - T_{loss} - T_{RL}}{I_{DS} + R^2 I_E}, \qquad \dot{R} = \frac{dR}{dt}$$

where α_{DS} = acceleration of the vehicle reflected to the drive shaft, $R = \frac{S_E}{S_{DS}}$, I_E = engine inertia, I_{DS} = vehicle inertia at the drive shaft, S_E =engine speed, S_{DS}= drive shaft speed, T_E = engine torque, T_{loss} = torque losses, and T_{RL} = road load torque at the drive shaft. Because the first term $-\dot{R} I_E S_E$ and the second term $T_E R$ generally oppose each other, the acceleration of the car and the torque and speed of the engine are difficult to control simultaneously. As a result, the best efficiency and minimum emissions for a gasoline or diesel engine cannot be realized without a sacrifice in performance. The Applicant has overcome this problem by configuring the motor controller to operate the electric motor or generator in a manner that varies engine power output. The motor or generator can then be used to allow the engine to operate at "wide open throttle" (*WOT*), or along the "Ideal Torque/Speed Operating Line" (*IOL*) for best efficiency and lowest emissions, or along any other predetermined operation line. In this way, the engine can be run continuously while energy flows into or out of the battery energy storage system connected to the electric motor/generator. If the battery is large enough

to drive the vehicle a long distance, then the efficiency of energy into and out of the battery is high since the battery internal resistance is low.

Therefore, for the reasons stated above, Claims 1-8, as well as the claims that depend therefrom, are patentable over Ibaraki et al. since Ibaraki et al. does not teach, and does not suggest or provide motivation or incentive for, using an electric motor or generator to vary engine power output in a hybrid electric vehicle.

(b) Claims 9-11. In response to the rejection of Claims 9-11, the Applicant has amended Claim 9 to recite that the electric motor is used to vary the engine power output as discussed above with regard to Claim 1. Accordingly, Claims 9-11 are patentable for the reasons set forth above with regard to Claim 1.

(c) Claim 21. In response to the rejection of Claim 21, the Applicant has amended Claim 21 to recite that the electric motor is used to vary the engine power output as discussed above with regard to Claim 1. Accordingly, Claim 21 is patentable for the reasons set forth above with regard to Claim 1.

(d) Claim 22. In response to the rejection of Claim 22, the Applicant has amended Claim 22 to recite that the electric motor is used to vary the engine power output as discussed above with regard to Claim 1. Accordingly, Claim 22 is patentable for the reasons set forth above with regard to Claim 1.

In view of the foregoing, Claims 1-11, 21 and 22 are patentable over Ibaraki et al. In addition, for the reasons discussed below, Claims 1-11, 21 and 22 are patentable over Yamaguchi, as well as the combined teachings of Ibaraki et al. and Yamaguchi.

7. Rejection of Claims 12-15 under 35 U.S.C. §102(e).

Claims 12-15 were rejected under 35 U.S.C. §(e) as being anticipated by Yamaguchi. In support of the rejection of Claims 12-15, the Examiner stated that "Yamaguchi discloses a generator 3 coupled to the output of engine 2 and a generator controller 12. Also Yamaguchi discloses that the generator comprises a generator/motor (figure 1) and that the controller varies positive and negative output torque in accordance to predetermined characteristics (column 17, lines 23-25)."

In response, the Applicant respectfully notes that the portion of Yamaguchi cited by the Examiner does not describe varying engine power output with a generator as recited in Applicant's Claims 12-15. The portion of Yamaguchi cited by the Examiner recites "motor controlling means for compensating for a variance in the output torque which occurs as the engine speed-torque relationship is changed by said engine controller means by controlling the motor torque output by said electric motor." Note that Yamaguchi refers to controlling motor torque output by said electric motor, **not** varying engine power output with a generator coupled to the engine. Again, as discussed above with regard to Ibaraki et al., the Applicant's approach is radically different than what is taught by Yamaguchi.

In Yamaguchi, engine torque of a combustion engine 2 and motor torque of a generator/motor 3 are transmitted to a driving output system as the driving torque. The motor torque is controlled by the controller 10 to compensate for variations in engine torque. Note that compensation for variations in engine torque, e.g., by amending the engine torque, is not the same as varying engine power output using a generator as recited in Applicant's Claims 12-15.

Therefore, for the reasons stated above, Claims 12-15 are patentable over Yamaguchi et al. since that reference does not teach, and does not suggest or provide motivation or incentive for, using a generator or an electric motor to vary engine power output in a hybrid electric vehicle.

8. Rejection of Claims 19 and 20 under 35 U.S.C. § 103.

Claims 19 and 20 were rejected under 35 U.S.C. § 103 as being unpatentable over Yamaguchi et al. in view of Kawakatsu et al. In support of the rejection, the Examiner stated that while "Yamaguchi does not disclose a motor/generator coupled to a shaft and wheels involve in the transmission system" Kawakatsu et al. shows that element.

In response, the Applicant has amended Claims 19 and 20 to recite that the motor/generator (Claim 19) or electric motor (Claim 20) is used to vary the engine power output as discussed above with regard to Claims 1 and 12. Accordingly, Claims 19 and 20 are patentable for the reasons set forth above with regard to Claims 1 and 12. Neither Ibaraki et al. nor Yamaguchi et al., whether viewed singly or in combination, teaches, suggests or provides motivation or incentive for that feature of Claims 19 and 20. Furthermore, Kawakatsu et al., which was cited as showing a motor/generator coupled to a transmission system, does not teach, suggest or provide motivation or incentive for that element. Therefore, Claims 19 and 20 are patentable over the cited references.

9. Information Disclosure Statement.

The Applicant respectfully calls to the attention of the Examiner that the Examiner overlooked placing his initials next to the two publications listed in page 2 of

Applicant's Form 1449 filed on December 4, 2000. All other references were initialed as being considered. The Applicant respectfully requests that those references be shown as considered on the previously filed information disclosure statement.

10. Conclusion.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

The Applicant also respectfully requests a telephone interview with the Examiner in the event that there are questions regarding this response, or if the next action on the merits is not an allowance of all pending claims.

Date: 8/10/01

Respectfully submitted,

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